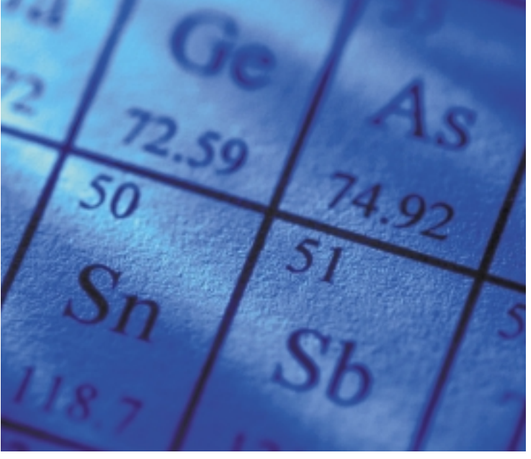


Health and safety should be an integral part of science education in the classroom. Even though the teacher is ultimately responsible for the safety of the students in the laboratory, students should learn that they, too, have a personal responsibility for their health and safety. Whether handling chemicals in a laboratory or using and disposing of chemical products at home, we all have a responsibility to handle chemicals properly, especially hazardous chemicals, to prevent accidents and protect the well being of ourselves and others.

Teachers, especially those who are new to laboratory instructions or chemistry, should consider the hazards, precautions, and emergency procedures of safe chemical handling before introducing students to the laboratory.

This brochure is a starting point, primarily for secondary and high school science teachers, to direct you to suggested resources to find the information you need to ensure a safer working environment for you and your students. **This brochure is not all inclusive and is not a substitute for a comprehensive set of safety guidelines specifically adopted for your school laboratory.**

Chemical Storage Reminders

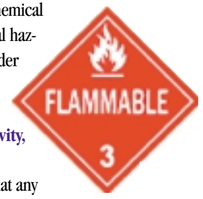
Store chemicals in their own locked, ventilated room. Flammable chemicals should be stored in locked, fireproof cabinets (OSHA/NFPA approved flammable cabinets). Be sure there is a prep room for chemical solutions. Restrict students and unauthorized personnel from access to the prep room and chemical storage area.

- A storage area should be neat and orderly.[1]
- Make sure shelf units are stable.[1]
- Never store chemicals on the floor.[1]
- Each storage room should have 2 exits.[1]
- Keep a minimum of flammable liquids.[1]
- Do not store chemicals in a household refrigerator (non-explosion-proof).[1]
- Store all chemicals away from direct light.[1]
- Label each chemical with date of receipt and date opened and with the initials of the person responsible.[1] If possible, keep certain items in the original shipping package, e.g. acids and bases in the special Styrofoam cubes.
- All chemical containers should be labeled with chemical name, type (acid, base, oxidizer, etc.) and degree of hazard. The information should correspond to your file of MSDSs.
- Do not store incompatible chemicals together.[1]
- Always store chemicals, especially corrosives, below eye level.
- Storage area should be ventilated by at least six changes of air per hour. Isolate the chemical storage exhaust from the building ventilation system.

Store Minimum Quantities of Chemicals

Try to store only a one-year supply or the shelf life of your most serious hazardous chemicals. If you order smaller quantities and packages of chemicals, the material will be fresher. The fresher the chemicals, the better your experiments and demonstrations will work. Also, disposal costs are less expensive with smaller amounts of chemicals. Most importantly, the risk of accidents and exposure to hazardous material is reduced with a smaller container.

Separate and Isolate Your Most Serious Hazards



An effective way to minimize a chemical accident is to isolate the chemical hazards. Chemicals generally fall under the following four classes of hazards:
1) flammability, 2) corrosivity, 3) toxicity, and 4) reactivity.
Teachers should keep in mind that any single chemical may present more than one hazard. **Never store different hazard classes together.**

A color-code system is most widely used in the chemical industry. For example, **Red=Flammable; White=Corrosive; Yellow=Reactive or Oxidizing; Blue=Health Hazard; and Green=General Storage.**

Refer to the National Fire Protection Association's (NFPA) "NIOSH diamond" and post it at all chemical storeroom entrances denoting the most hazardous chemical in each category within. The highest hazard number should be displayed for the most hazardous chemical stored in the room. (See **Other Sources** section for NFPA information: www.nfpa.org.)

Incompatible Chemicals

Be sure to store acids and bases separately. Keep in mind that some acids are incompatible with other acids. Organic acids are flammable or combustible. For example, acetic acid is an organic acid that should not be stored with acids that are oxidizers, such as chromic acid, nitric acid, and perchloric acid. Store flammables and combustibles separately from oxidizers.

Violent reactions may occur when the following chemicals from different storage groups are mixed:[2]

- Acids + Bases =Heat and/or Explosion
- Oxidizers + Flammables or Combustibles = Fire and/or Explosion
- Water-sensitives + Water = Fire and/or Explosion

For more information on chemical reactivity and incompatibility, refer to chemical manuals. Use a reputable guide, i.e., National Institute for Occupational Safety and Health/Occupational Safety and Health Administration (NIOSH/OSHA) to help you properly separate incompatible chemical families, (See **Other Sources** section: www.cdc.gov/niosh and www.osha.gov.) such as:

American Chemical Society, "Chemical Safety for Teachers and Their Supervisors: Grades 7-12," Washington, DC: ACS. (Single copies are free.)

National Institute for Occupational Safety and Health, "NIOSH Pocket Guide to Chemical Hazards," NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1997 (or latest edition).

Material Safety Data Sheets (MSDSs)

Whenever you buy a chemical from a science supply company, the company is required by law to provide a sheet of paper for every chemical called a Material Safety Data Sheet (MSDS). The sheet lists critical information on safety precautions of the hazards of the chemical, which guides emergency personnel, such as firefighters, who might be responding to an accident involving a particular chemical. Because of this, schools must keep these sheets when they unpack chemical shipments. The MSDS should be placed in a central location that is readily accessible for teachers to locate in case of a chemical accident.[3] Be sure to read and understand the MSDS for each chemical before beginning any experiment.

Refer to the MSDS and a safety manual for information on reactivity. The MSDS is not always a complete source of information. A significant percentage of currently available MSDSs do not fully identify or describe hazards and precautions of the chemicals to which they pertain.

As a buyer of chemical products for educational laboratories, your laboratory may be required to meet OSHA Hazard Communication Standard 29 CFR 1910.1450, including a written Chemical Hygiene Plan[4], and/or county/state codes that address hazards that occur in a laboratory. (See **Others Sources** section—www.osha.gov.) **Check with your district supervisor for local/state requirements and mandates for laboratory safety.**

Take Inventory

Maintain a chemical inventory to avoid purchasing unnecessary quantities of chemicals. Inventory all chemicals annually. Take an inventory of all the chemicals in your storage area, laboratory and classroom. Take notes including the name of the chemical, its shelf location, and the approximate amount of chemical in each container.

"The shelf location of each chemical is important because it is likely that the same chemical will be found in several locations. The shelf location information will help you track down and consolidate these chemicals."[5]

The inventory list should be updated as chemicals are used and replacement chemicals are received. Keep an updated copy of the inventory in the science laboratory and give a copy to the school administrator and local fire marshall.

Chemical Disposal

Indications for disposal of chemicals include the following:[1]

- Slightly cloudy liquids
- Chemicals that are changing color
- Spotting on solids
- Caking of anhydrous materials
- Existence of solids in liquids or liquids in solids
- Evidence of reaction with water
- Damage to the container

Waste disposal of certain chemicals is governed by:

- The Resource Conservation and Recovery Act (RCRA)
- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- State and local regulations vary on the proper disposal procedures for any chemical waste. State contact information in your area can be found at www.epa.gov/epaoswer/hazwaste/state/links.htm

Emergency Planning

Before handling or moving a chemical for disposal, be sure to refer to its MSDS and a safety manual for disposal precautions. Contact your school system's/institute's Safety Coordinator.

An affordable way to dispose of chemicals is to contact your state or local government. In some cases your city's or county's public works or solid waste departments offer chemical disposal programs for organizations deemed to be small quantity generators, which typically include schools. Search under Solid Waste Departments or Public Works in the White Pages under Government Listings. In some cases, your local fire marshall can help you remove flammables.

If you need a private waste service contractor, make sure they are reputable and have experience working with schools.

A reliable disposal contractor should perform the following services: [1]

- Pack the wastes properly
- Label the containers properly
- Prepare the necessary forms including a manifest
- Distribute the forms to proper destinations
- Transport the wastes to the disposal site
- Certify that the wastes have been properly disposed of

Maintaining a safe environment in the lab has been the focus of this brochure. But what happens when something goes wrong? Planning for emergencies is just as important as preventing their occurrence.

The emergency planning process involves several steps. First, think of the opportunities for something to go wrong, whether caused by human error, external factors such as power failures, weather emergencies, or equipment failures. Then, identify and take preventive measures that will minimize the chance that the incident will occur or will minimize the consequences.

Next, determine the response if an incident does occur. When should students be evacuated? Should emergency services be called? Should a class demonstration on how to use a fire extinguisher be part of the general chemistry curriculum? Should staff members be trained in CPR and first aid? [6]

The head of the science department should make sure key people including the principal and emergency responders, such as the local fire chief, are involved in the emergency planning process and aware of the safety plan. Once a Board Policy is in place, each school should develop a safety plan. A copy of the plan should be given to the local fire department. Keep a copy of the plan in the science laboratory and in the main office so it is readily available. Train faculty and students, and practice the plan so it becomes a school-wide effort.

Pre-planning and proper incident management can make the difference between a minor inconvenience and serious injury or community impact.

References

1) Veronda, Brenda. "Chemical Storage and Disposal," excerpts from a presentation at the CICI Science Teachers Workshop, Carus Chemical Company, 2000.

2) Young, Jay A.., Chemical Safety and Health Consultant. Phone Correspondence, May 2001.

3) Kaufman, James A., "Safety Is Elementary," The Laboratory Safety Institute, Natick, MA, January 2000.

4) Sargent-Welch Catolog 2001, www.sargentwelch.com.

5) Flinn Scientific, Inc., "Seven-Step Plan to Clean Up Your Chemical Storage Area," and the Flinn Catalogue can be found online at www.flinnsci.com.

6) Grimm, Kimberly, Safety and Training Manager, ABCO Industries. Phone/Fax Correspondence, May 2001.

Other Sources

Scientific, Educational and Trade Associations

American Chemistry Council (ACC)
1300 Wilson Boulevard
Arlington, VA 22209
Phone: 703/741-5832
Fax: 703/741-6832
Web site:
www.americanchemistry.com/chemecology
(on-line science magazine)
E-mail:
Chem_Ecology@americanchemistry.com

American Chemical Society (ACS)
1155 16th Street, NW
Washington, DC 20036
Phone:1/800/227-5558 (U.S. only)
202/872-4600 (outside the U.S.)
Fax: 202/872-4615
Web site: www.chemistry.org
E-mail: help@acs.org

Resources:
Young , J., Breazeale, J. et al., ACS, "Safety in Academic Chemistry Laboratories," 6th ed., 1998.
American Chemical Society, "Chemical Safety for Teachers and Their Supervisors: Grades 7-12," Washington, DC, 2001. (Single copies are free.)

American National Standards Institute (ANSI)
25 West 43rd Street, 4th Floor
NY, NY 10036
Phone: 212/642-4900
Fax: 212/398-0023
Web site: www.ansi.org
E-mail: ansionline@ansi.org

ANSI reviews and approves various standards. For example, Z87.1 (eye face protection/approved safety goggles), Z358.1 (Safety and Shower Wash), and Z9.5 (laboratory ventilation)

National Fire Protection Association (NFPA)
One Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Phone: 617/770-3000
Fax: 617/770-0700
Web site: www.nfpa.org
E-mail: library@nfpa.org

Resources:
NFPA, "Fire Protection for Laboratories Using Chemicals," 2000. (Cost: $25.25, not including shipping and handling.)
NFPA, "Fire Protection Guide to Hazardous Materials," 1997. (Cost: $101.25, not including shipping and handling.)

The National Academies/ National Research Council
2101 Constitution Ave., N.W.
Washington, DC 20418
Phone: 202/334-2000
Web site: www.nas.edu/nrc
E-mail: news@nas.edu

Resource:
NRC, "Prudent Practices in the Laboratory," National Academy Press, Washington, DC, 1995. (Cost: $69.95, not including shipping and handling.)

National Science Teachers Association (NSTA)
1840 Wilson Boulevard
Arlington, VA 22201-3000
Phone: 703/243-7100
Fax: 703/243-7177
Web site: www.nsta.org
E-mail: n/a

Resources:
Biehle, James, LaMonie Motz, and Sandra West. "NSTA Guidelines for Science Facilities," NSTA Press, Arlington, VA, 1999. (Cost: $69.95 per copy.)

Gerlovich, J. A., J. Whitset, S. Lee, and R. Parsa. "Surveying Safety: How Researchers Address Safety in the Science Classroom in Wisconsin," *The Science Teacher,* Vol. 68, No.4, pp. 31-35, April 2001.

The Council of State Science Supervisors (CSSS)
You may want to contact your state science supervisor.
For a listing of members and contact information go to http://csss.enc.org

Resource:
"Science and Safety, Making the Connection" can be downloaded online.

The Laboratory Safety Institute
192 Worcester Road
Natick, MA 01760-2252
Phone: 508/647-1900
Fax: 508/647-0062
Web site: www.labsafety.org
E-mail: Labsafe@aol.com

Resources:
Kaufman, James A. "Seventy Years of Progress," 2000 (or most recent edition).
Kaufman, James A. "Laboratory Safety Guidelines," 2nd ed. Dow Chemical Company, Midland, MI, 1986. (Revised in 1997.)

Uniform Fire Code Association (UFCA)
300 N. Main Street
Fallbrook, CA 92028
Phone: 760/723-6911
Fax: 760/723-6912
Web site: www.ufca.net
E-mail: ufcadmin@ufca.net

Reference: Uniform Fire Code

Government Agencies

Environmental Protection Agency (EPA) Headquarters
1200 Pennsylvania Ave., NW
Washington, DC 20460
Phone: 202/260-2090
Web site: www.epa.gov

National Institute for Occupational Safety and Health (NIOSH)
NIOSH Publications
4676 Columbia Parkway, C-13
Cincinnati, Ohio 45226-1998
Phone:1/800/356-4674
513/533-8328 (outside the U.S.)
Fax: 513/533-8573
Web site: www.cdc.gov/niosh
E-mail: pubstaff@cdc.gov

Resource:
National Institute for Occupational Safety and Health. "NIOSH Pocket Guide to Chemical Hazards." NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1997 (or latest edition). (Cost: free — can be downloaded online.)

U.S. Department of Labor Occupational Safety and Health Administration (OSHA)
200 Constitution Avenue, N.W.
Washington, DC 20210
Phone: 202/693-2000
Web site: www.osha.gov

References: (OSHA) Hazard Communication Standard 29 CFR 1910.1200 and Occupational Exposure to Hazardous Chemicals in Laboratories 29 CFR 1910.1450.

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